WHAT IS CLAIMED IS:

1. A method of forming cooling elements in a semiconductor substrate, comprising:

coating a backside of the semiconductor substrate with a first mask layer;

forming a plurality of trench patterns in the first mask layer;

etching the semiconductor substrate to form a plurality of trenches along the plurality of trench patterns; and

depositing thermally conductive material in the plurality of trenches.

2. The method as recited in claim 1, further comprising:

forming a first diffusion layer in the semiconductor substrate;

forming a second diffusion layer in the first diffusion layer; and

doping the second diffusion layer with a dopant having a polarity opposite a polarity of the semiconductor substrate.

3. The method as recited in claim 2, further comprising stopping the etching of the semiconductor substrate when the dopant contained in the second diffusion layer is detected in a product of the etching.

4. The method as recited in claim 1, wherein the first mask layer is a photoresist.

5. The method as recited in claim 1, wherein the trench patterns are formed by one of optical, x-ray, extreme ultra-violet, electron beam and ion beam lithographic techniques.

6. The method as recited in claim 1, wherein etching of the semiconductor substrate is performed with Cl_2-based plasma.

7. The method as recited in claim 1, wherein the plurality of trenches are formed in the vertical direction.

8. The method as recited in claim 1, wherein the step of depositing thermally conductive material is performed by one of chemical vapor deposition, atomic layer deposition, physical vapor deposition and electroplating.

9. The method as recited in claim 1, wherein the thermally conductive material is made from one of aluminum nitride, aluminum, copper-tungsten, silicon carbide, gold, copper, diamond and silver.

10. The method as recited in claim 1, wherein the semiconductor substrate is one of a complimentary metal oxide semiconductor wafer and a silicon-on-insulator wafer.

11. The method as recited in claim 1, wherein the plurality of trenches are formed in an intergrated-circuit chip of the semiconductor substrate.

12. The method as recited in claim 1, wherein the step of etching the semiconductor substrate to form the plurality of trenches is performed away from at least one of a passivation layer, an interconnect layer, a device layer and a doped well structure of the semiconductor substrate.

13. The method as recited in claim 1, wherein the plurality of trenches are formed one of before and after processing of remaining portions of the semiconductor substrate.

14. The method as recited in claim 1, further comprising integrating an external heat sink on the backside of the semiconductor substrate.

15. The method as recited in claim 1, further comprising integrating an active cooling apparatus on the backside of the semiconductor substrate.

16. The method as recited in claim 15, wherein the step of integrating the active cooling apparatus on the backside of the semiconductor substrate includes:

coating the backside of the semiconductor substrate with a second mask layer;

patterning the second mask layer;

etching a continuous trench into the backside of the semiconductor substrate;

forming at least one opening in the continuous trench for allowing coolant supplied from the active cooling apparatus to one of exit and enter the continuous trench; and

positioning the active cooling apparatus on the backside of the semiconductor substrate.

17. The method as recited in claim 15, wherein the active cooling apparatus is one of a thermal electric cooling component, a micro-fan device and a micropump.

18. The method as recited in claim 15, wherein the active cooling apparatus is one of directly fabricated on the backside of the semiconductor substrate and separately built and mounted on the backside of the semiconductor substrate.

19. A method of forming an active cooling apparatus on a semiconductor substrate, comprising:

coating the backside of a first semiconductor substrate with a mask layer;

patterning the mask layer;

etching a first continuous trench into the backside of the first semiconductor substrate;

forming at least one opening in the first continuous trench for allowing coolant supplied from the active cooling apparatus to one of exit and enter the first continuous trench; and

positioning the active cooling apparatus on the backside of the first semiconductor substrate.

20. The method as recited in claim 19, wherein the active cooling apparatus is one of a thermal electric cooling component, a micro-fan device and a micropump.

21. The method as recited in claim 19, wherein the active cooling apparatus is one of directly fabricated on the backside of the first semiconductor substrate and separately built and mounted on the backside of the first semiconductor substrate.

22. The method as recited in claim 19, further comprising:

forming a second semiconductor substrate including a second continuous trench; and

fastening the second semiconductor substrate to the first semiconductor substrate at a position between the backside of the first semiconductor substrate and the active cooling apparatus, whereby the active cooling apparatus rests on the second semiconductor substrate.

23. The method as recited in claim 22, wherein the second continuous trench is a mirror image of the first continuous trench of the first substrate.

24. The method as recited in claim 22, wherein the step of fastening includes one of anodic bonding and metallurgical soldering.

25. The method as recited in claim 22, wherein the second semiconductor substrate includes at least one opening in the second continuous trench for allowing the coolant supplied from the active cooling apparatus to one of exit and enter the second continuous trench.

26. The method as recited in claim 19, wherein the mask layer is a photoresist.

27. The method as recited in claim 19, wherein the first continuous trench is formed in the horizontal direction.

28. The method as recited in claim 19, wherein the first semiconductor substrate is one of a complimentary metal oxide semiconductor wafer and a silicon-on-insulator wafer.

29. The method as recited in claim 22, wherein the second semiconductor substrate is one of a silicon substrate and a plate-glass substrate.

30. The method as recited in claim 19, wherein the first continuous trench is formed in an intergrated-circuit chip of the first semiconductor substrate.

31. A cooling system for a semiconductor substrate, comprising:

a plurality of trenches formed from a backside of the semiconductor substrate; and

thermally conductive material deposited in the plurality of trenches.

32. The cooling system as recited in claim 31, further comprising:

a first diffusion layer formed in the semiconductor substrate; and

a second diffusion layer formed in the first diffusion layer, wherein the second diffusion layer is doped with a dopant having a polarity opposite a polarity of the semiconductor substrate.

33. The cooling system as recited in claim 32, wherein the depth of the plurality of trenches ends at the second diffusion layer.

34. The cooling system as recited in claim 32, wherein the plurality of trenches are formed by etching the semiconductor substrate, from the backside of the semiconductor substrate, down to the second diffusion layer.

35. The cooling system as recited in claim 31, wherein the plurality of trenches are formed by etching the semiconductor substrate, from the backside of the semiconductor substrate, with Cl_2-based plasma.

36. The cooling system as recited in claim 31, wherein the plurality of trenches are formed in the vertical direction.

37. The cooling system as recited in claim 31, wherein the plurality of trenches are one of cylindrical, oval, square, triangular, S-shaped, T-shaped and U-shaped.

38. The cooling system as recited in claim 31, wherein deposition of the thermally conductive material is performed by one of chemical vapor deposition, atomic layer deposition, physical vapor deposition and electroplating.

39. The cooling system as recited in claim 31, wherein the thermally conductive material is made from one of aluminum nitride, aluminum, Cu-W, silicon carbide, gold, copper, diamond and silver.

40. The cooling system as recited in claim 31, wherein the semiconductor substrate is one of a complimentary metal oxide semiconductor wafer and a silicon-on-insulator wafer.

41. The cooling system as recited in claim 31, wherein the plurality of trenches are formed in an intergrated-circuit chip of the semiconductor substrate.

42. The cooling system as recited in claim 31, wherein the plurality of trenches are formed away from at least one of a passivation layer, an interconnect layer, a device layer and a doped well structure of the semiconductor substrate.

43. The cooling system as recited in claim 31, wherein the plurality of trenches are formed one of before and after processing of remaining portions of the semiconductor substrate.

44. The cooling system as recited in claim 31, further comprising an external heat sink on the backside of the semiconductor substrate.

45. The cooling system as recited in claim 31, further comprising an active cooling apparatus on the backside of the semiconductor substrate.

46. The cooling system as recited in claim 45, wherein the active cooling apparatus is connected to a continuous trench formed in the backside of the semiconductor substrate, and to at least one opening in the continuous trench for allowing coolant to enter the continuous trench from the active cooling apparatus.

47. The method as recited in claim 45, wherein the active cooling apparatus is one of a thermal electric cooling component, a micro-fan device and a micropump.

48. The method as recited in claim 45, wherein the active cooling apparatus is one of directly fabricated on the backside of the semiconductor substrate and separately built and mounted on the backside of the semiconductor substrate.

49. A cooling system for a semiconductor device, comprising:

an active cooling apparatus positioned on the backside of a first semiconductor substrate;

a first continuous trench formed in the backside of the first semiconductor substrate; and

at least one opening in the first continuous trench for allowing coolant supplied from the active cooling apparatus to one of exit and enter the first continuous trench.

50. The cooling system as recited in claim 49, wherein the active cooling apparatus is one of a thermal electric cooling component, a micro-fan device and a micropump.

51. The cooling system as recited in claim 49, wherein the active cooling apparatus is one of directly fabricated on the backside of the first semiconductor substrate and separately built and mounted on the backside of the first semiconductor substrate.

52. The cooling system as recited in claim 49, further comprising:

a second semiconductor substrate including a second continuous trench, wherein the second semiconductor substrate is fastened to the first semiconductor substrate at a position between the backside of the first semiconductor substrate and the active cooling apparatus, whereby the active cooling apparatus rests on the second semiconductor substrate.

53. The cooling system as recited in claim 52, wherein the second continuous trench is a mirror image of the first continuous trench of the first substrate.

54. The cooling system as recited in claim 52, wherein the second semiconductor substrate is fastened to the first semiconductor substrate by one of anodic bonding and metallurgical soldering.

55. The cooling system as recited in claim 52, wherein the second semiconductor substrate includes at least one opening in the second continuous trench for allowing the coolant supplied from the active cooling apparatus to one of exit and enter the second continuous trench.

56. The cooling system as recited in claim 49, wherein the first continuous trench is formed in the horizontal direction.

57. The cooling system as recited in claim 49, wherein the first semiconductor substrate is one of a complimentary metal oxide semiconductor wafer and a silicon-on-insulator wafer.

58. The cooling system as recited in claim 52, wherein the second semiconductor substrate is one of a silicon substrate and a plate-glass substrate.

59. The cooling system as recited in claim 49, wherein the first continuous trench is formed in an intergrated-circuit chip of the first semiconductor substrate.

60. A method of forming cooling elements in a semiconductor substrate, comprising:

etching the semiconductor substrate from a backside of the semiconductor substrate to form a plurality of trenches; and

depositing thermally conductive material in the plurality of trenches.